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IN THE EUROPEAN PATENT OFFICE

PATENT COOPERATION TREATY
International Preliminary Examining Authority
Attn: T. Timonen

In Re International Application of: THE GOVERNMENT OF THE UNITED STATES OF AMERICA...

International Application No.: PCT/US2004/032378
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COPY

For: AIR-SAMPLING DEVICE AND METHOD OF USE

Date: 16 August 2005

## RESPONSE TO WRITTEN OPINION

European Patent Office
Erhardstrasse 27
D-80331 Munich
GERMANY

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Dear Officer Timonen:

In response to the Written Opinion of the International Searching Authority mailed on 27 April 2005, replacement pages 26 and 29, including amendments to claims 12 and 34, are enclosed for consideration during preliminary examination under Article 34. Please replace pages 26 and 29 of the international application with the attached replacement pages 26 and 29. In the attached replacement pages, claims 12 and 34 are amended and the remaining claims are unchanged.

The Opinion contends that claims 1-2, 4, 8-9, 22, and 27-29 lack novelty in view of U.S. Patent No. 4,941,899 to Liu et al. (D1) and that claims 3, 5-7, 10-21, 23-26, and 30-39 lack inventive step in view of D1 and/or Patent No. HU 193,716 (D2). Applicants disagree with this contention for the following reasons.

<u>Claims 1-7:</u>

Independent claim 1 is directed to an apparatus for collecting airborne particles in a collection vessel. The apparatus comprises a retaining member adapted to be coupled to the collection vessel and having an air-inlet conduit and an air-outlet conduit. The air-outlet conduit is configured such that air flowing into the collection vessel establishes a cyclonic flow path to cause airborne particles to separate from the air.

A conventional cyclonic sampler, such as disclosed in D1, includes a vortex tube in which a cyclonic flow path is established, and a collection cap mounted below the vortex tube. Particles separated from the air stream in the vortex tube are deposited along the inner

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surface of the vortex tube or migrate downwardly into the collection cap. Unlike a conventional cyclonic sampler, the instantly claimed device utilizes a collection vessel that functions both as a vortex tube and a collection vessel to collect particles. In this way, all particles that are separated from the air stream are deposited directly in the collection vessel for subsequent analysis.

D1 discloses a particle collection device that includes a conventional cyclone sampler (col. 2, lines 29-30) comprising a vortex tube 17 and a removable collection cap 23 connected to the bottom of the vortex tube. In use, relatively larger particles are separated from the air stream in the vortex tube 17 and are deposited along the inner surface of the tube 17 or migrate downwardly into the collection cap 23. There is no indication that the cyclonic flow path in the vortex tube 17 extends into the collection cap 23. As noted above, in the device of claim 1, a cyclonic flow path is established in the collection vessel itself so that all particles separated from the air stream are deposited directly in the collection vessel. Further, there is no teaching or suggestion in D1 as to how the vortex tube 17 and/or the collection cap 23 might be adapted so as to establish a cyclonic flow path within the collection cap 23.

Accordingly, claim 1 clearly recites subject matter that is patentable over D1.

Dependent claims 2-11 recite additional features of Applicants' device not taught or suggested by D1 and/or D2.

For example, claim 3, in combination with claim 2, recites that the air-inlet conduit extends at an angle of about 30 degrees to 45 degrees with respect to a plane that is parallel to the open end of the collection vessel. In contrast, in D1, the inlet air 16 flows through air inlet 15 in a direction that is parallel to the open end of the collection cap (and perpendicular to the longitudinal axis of the sampler). This is done to achieve the greatest number of revolutions in the vortex in the vortex tube 17, thereby optimizing the removal efficiency of the device. Modifying the air inlet in D1 to extend at a 30 to 45 degree angle, as in the claimed device, would have been against conventional wisdom because this would have decreased the efficiency of the device of D1. Thus, a skilled person would not been motivated to modify the device of D1 to include an angled air inlet conduit.

Claim 7, in combination with claim 6, recites that the air inlet comprises a first passageway that extends generally tangentially with respect to an inner surface of the collection vessel. As shown in FIGS. 3-5 of the present application, inlet passageway 48 allows inlet air to flow into the open end of the collection vessel 28 in a direction tangential to the inner surface of the collection vessel, which is effective to establish a cyclonic flow path within the collection vessel (see the direction of the inlet air through passageway 48).

In contrast, in D1, the air inlet is an opening 15 in the side wall of tube 19. The opening 15 does not extend into the tube 19 so as to form a passageway, nor does it extend

generally tangentially with respect to the inner surface of the collection cap 23. Furthermore, since the vortex is established in the vortex tube 17, there is no need to modify the device of D1 to include an inlet passageway that extends generally tangentially to the inner surface of the collection cap 23.

Claim 10, in combination with claim 8, recites that the retaining member is configured to support two collection vessels in the same orientation. Unlike claim 10, in D1, the primary cyclone device (the vortex tube 17 and collection cap 23) (FIG. 1) are situated in a perpendicular relationship with respect to the secondary cyclone device 30 (FIG. 3). D1 does not provide any reason why a skilled person would want to modify the device so that the primary and secondary cyclone devices are in the same orientation. Furthermore, as shown in FIGS. 1 and 2 of D1, vortex tube 17 of the primary cyclone device receives inlet air from tube 19, which serves as an inlet to the secondary cyclone device 30. Applicants submit that the vortex tube would need to extend co-axially with respect to tube 19 (and perpendicular to the secondary cyclone sampler), as shown in the figures, in order to establish a vortex in the vortex tube. It appears that any modification from this configuration would render the device inoperable for its intended purpose.

<u>Claims 12-21:</u>

Independent claim 12 recites an apparatus comprising a collection vessel, an air-inlet conduit, and an air-outlet conduit. Claim 12 has been amended to recite that the air-inlet conduit is non-orthogonal and non-parallel to a line extending longitudinally with respect to the collection vessel and intersecting the air-inlet conduit. The air-inlet conduit and the air-outlet conduit are situated to cause air flowing through the collection vessel to create a vortex, thereby causing airborne particles to separate from the air flowing through the collection vessel.

As discussed above, D1 discloses a conventional cyclone sampler (col. 2, lines 29-30) in which a vortex is create in a vortex tube 17, causing separated particles to fall into collection cap 23 by gravity. There is no evidence that a vortex can be created in the collection cap 23, as is the case in the instantly claimed apparatus.

Moreover, in regards to claim 12, the Opinion contends that D2 discloses a collection device having an air-inlet conduit that is non-orthogonal and non-parallel to a line extending longitudinally with respect to a collection vessel, and further that a skilled person would have used the construction of D2 to modify the device of D1.

Applicants disagree that D2 shows the construction recited in claim 12. As shown in FIGS. 3 and 4 of D2, the device includes an air-inlet conduit comprising a vertical portion 11 and a horizontal portion 13. The vertical portion 11, which extends in a parallel relationship with respect to the collection tube, is parallel to all lines extending longitudinally with respect

to the collection vessel. The horizontal portion 13 extends in a horizontal plane that is perpendicular to the central longitudinal axis of the collection vessel (FIG. 4). Thus, the horizontal portion 13 would be orthogonal (perpendicular) to any line intersecting the horizontal portion 13 and extending longitudinally with respect to the collection vessel. Accordingly, no combination of D1 and D2 would yield the combination of features recited in claim 12.

Dependent claims 13-21 recite additional features of Applicants' device not taught or suggested by D1 and/or D2.

Claims 22-33:

Independent claim 22 recites a method for analyzing airborne particles, comprising flowing untreated air into a collection vessel, establishing a reverse cyclonic air flow pattern in the collection vessel such that particles are separated from the air and are collected in the collection vessel, and performing an analysis of the particles separated from the air.

The device disclosed in D1, as presently understood, cannot be used to practice the method recited in claim 22. This is because the device of D1 includes a conventional cyclone sampler in which a vortex is created in a vortex tube 17, causing separated particles to fall into collection cap 23 by gravity. There is no evidence that a cyclonic air flow pattern can be created in the collection cap 23, as is the case the instantly claimed method.

Dependent claims 23-33 recite additional features of Applicants' method not taught or suggested by D1.

For example, claim 23 recites performing an analysis on the collected particles while the particles are still in the collection vessel. In contrast, when using a conventional cyclonic sampler, such as disclosed in D1, the collected particles typically are transferred from the collection cap to a suitable microcentrifuge tube, such as an Eppendorf® tube, for performing an analysis on the collected particles. Since the collection cap 23 in D1 is not a microcentrifuge tube, it would not be used for performing an analysis on the collected particles.

Claim 24, which depends from claim 23, further recites performing PCR on the particles while the particles are still in the collection vessel. Applicants submit that to perform PCR on particles collected by the collection cap 23 in D1, the particles first would be transferred to a suitable microcentrifuge tube; PCR would not be performed on the particles while still in the collection cap 23.

Claims 34-39:

Independent claim 34 recites a method for collecting airborne particles for analysis. Claim 34 has been amended to recite flowing air into a cyclone device along a flow path in a direction that extends generally tangentially with respect to an inner surface of cyclone

device, the flow path being non-orthogonal and non-parallel to a line that is parallel to a longitudinal axis of the cyclone device and intersects the flow path, wherein the air flowing through the cyclone device establishes a cyclone (added language underlined).

Neither D1 nor D2 can be used to practice the method recited in claim 34. In D1, the inlet air forms a flow path 16 that extends through inlet 15 in a direction that is orthogonal (perpendicular) to the longitudinal axis of the vortex tube 17 (see FIG. 1). Hence, the flow path 16 would be perpendicular to any line that is parallel to the longitudinal axis of the cyclone and intersects the flow path.

The device of D2 includes an air-inlet conduit comprising a vertical portion 11 and a horizontal portion 13 (see FIGS. 3 and 4). The vertical portion 11, which extends in a parallel relationship with respect to the vortex tube 10, is parallel to all lines extending longitudinally with respect to the vortex tube. The horizontal portion 13 extends in a horizontal plane that is perpendicular to the central longitudinal axis of the vortex tube (FIG. 4). Thus, the horizontal portion 13 would be orthogonal (perpendicular) to any line that is parallel to the longitudinal axis of the vortex tube 10 and intersects the flow path through the horizontal portion 13.

Accordingly, the method of claim 34 is neither taught nor suggested by D1 or D2 (either alone or in combination).

Dependent claims 35-39 recite additional features of Applicants' method not taught or suggested by D1 and/or D2. For example, claim 36 recites that the cyclone device is a microcentrifuge tube. Because particles are collected directly in the microcentrifuge tube, there is no sample transfer loss from transferring collected particles from a collection cap into a microcentrifuge tube. In contrast, to perform an analysis on particles collected using the device of D1 (or D2), the collected particles would be transferred from the collection cap 23 into a microcentrifuge tube for subsequent analysis. Applicants submit that the use of a microcentrifuge tube as a cyclone device is not well known in the art, and therefore any modification of D1 to include a microcentrifuge tube would involve an inventive step.

Please telephone the undersigned at the telephone number listed below if anything further is required.

Respectfully submitted,

KLARQUIST SPARKMAN, LLP

One World Trade Center
Suite 1600
121 S.W. Salmon Street
Portland, Oregon 97204
Telephone: (503) 595-5300
Facsimile: (503) 595-5301

By________________________
Jeffrey B. Haendler
Registration No. 43,652

cc: Docketing

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an air-inlet conduit for conducting air into the collection vessel, the air-inlet conduit being non-orthogonal and non-parallel to a line extending longitudinally with respect to the collection vessel and intersecting the air-inlet conduit; and

an air-outlet conduit for conducting air out of the collection vessel;

wherein the air-inlet conduit and the air-outlet conduit are situated to cause air flowing through the collection vessel to create a vortex, thereby causing airborne particles to separate from the air flowing through the collection vessel.

13. The apparatus of claim 12 wherein:

the collection vessel is a first collection vessel, the air-inlet conduit comprises a first air-inlet conduit, and the air-outlet conduit comprises a first air-outlet conduit; and

the apparatus further comprises:

a second collection vessel;

a second air-inlet conduit in fluid communication with the first air-outlet conduit so that air flowing through the first air-outlet conduit is conducted into the second collection vessel through the second air-inlet conduit, the second air-inlet conduit being non-orthogonal to a line extending longitudinally with respect to the second collection vessel; and

a second air-outlet conduit for conducting air out of the second collection vessel;

wherein the second air-inlet conduit and the second air-outlet conduit are situated to cause air flowing through the second collection vessel to create a vortex, thereby causing airborne particles to separate from the air flowing through the second collection vessel.

14. The apparatus of claim 13, wherein the first collection vessel is supported in the same orientation as the second collection vessel.

28. The method of claim 27, wherein the particles collected in the second collection vessel are generally smaller than the particles collected in the first collection vessel.

29. The method of claim 27, further comprising performing an analysis on the particles that are collected in the second collection vessel.

30. The method of claim 27, wherein the analysis is performed while the particles are still in the second collection vessel.

31. The method of claim 22, wherein the analysis of the particles is performed while air is flowing through the collection vessel.

32. The method of claim 22, wherein the particles are bioaerosols.

33. The method of claim 22, wherein the particles collected in the collection vessel are approximately equal to and greater than 2 microns in size.

34. A method for collecting airborne particles for analysis, the method comprising:

flowing air into a cyclone device along a flow path in a direction that extends generally tangentially with respect to an inner surface of cyclone device, the flow path being non-orthogonal and non-parallel to a line that is parallel to a longitudinal axis of the cyclone device and intersects the flow path, wherein the air flowing through the cyclone device establishes a cyclone; and

separating airborne particles from the air flowing through the cyclone device.

35. The method of claim 34, wherein the air flowing through the cyclone device establishes a reverse-flow cyclone.